Two decades of intense convection from TRMM, GPM and constellation satellites

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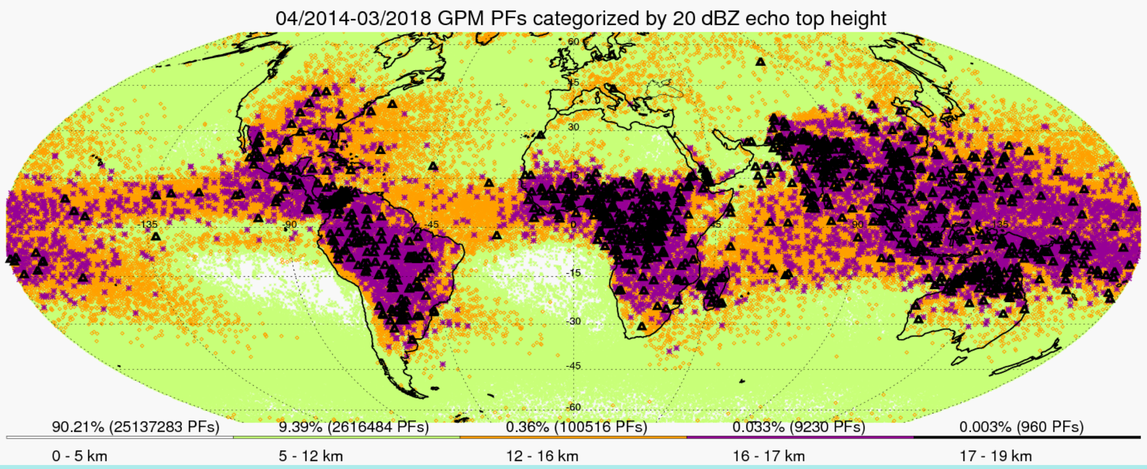
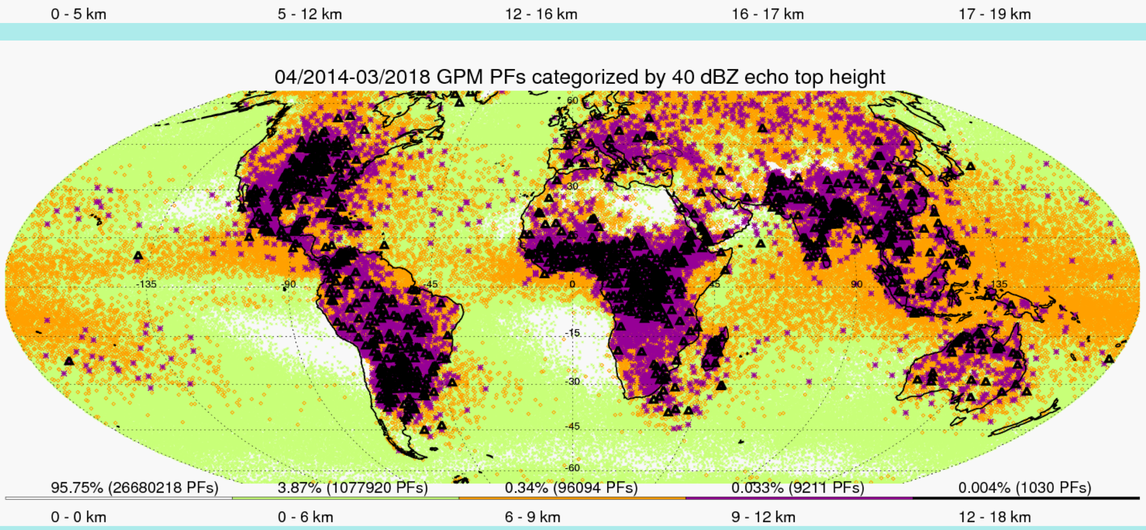
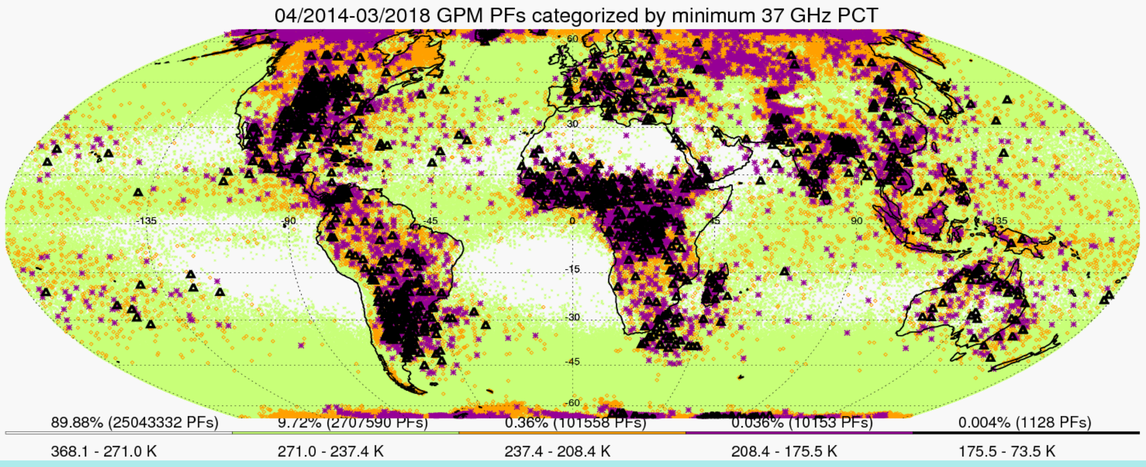
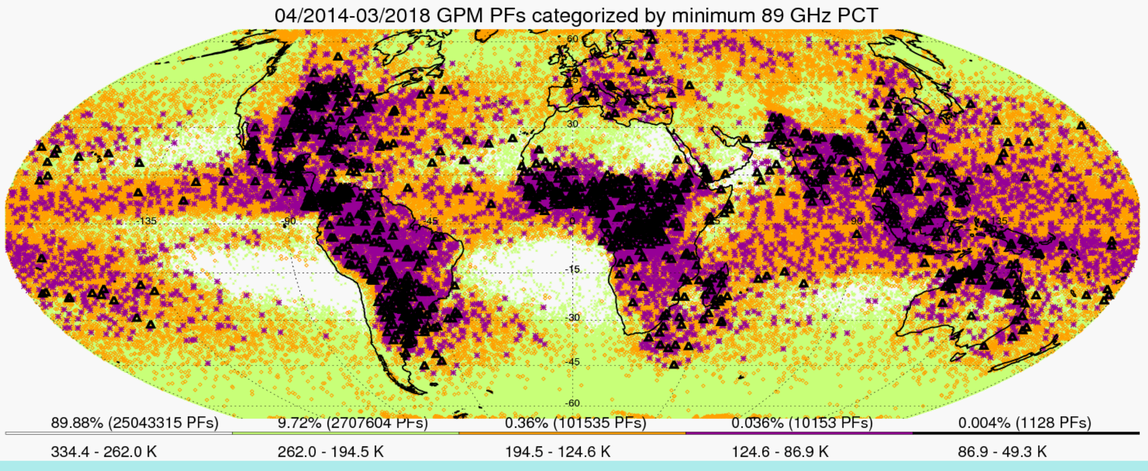
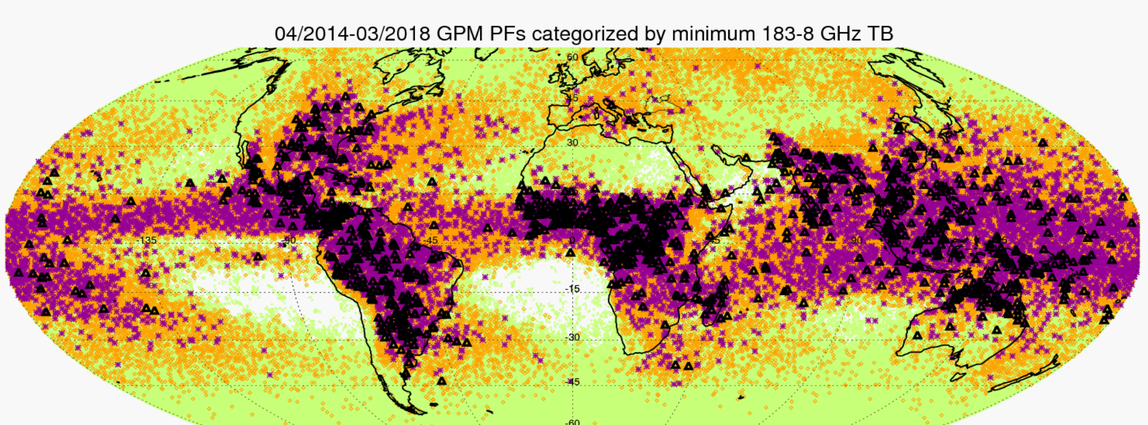
Intense convection from the GPM core satellite

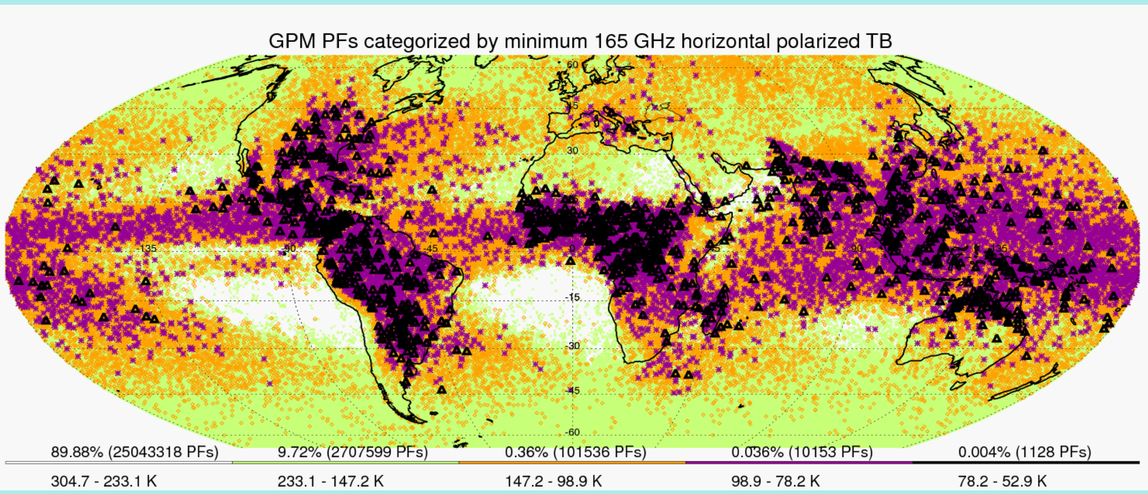






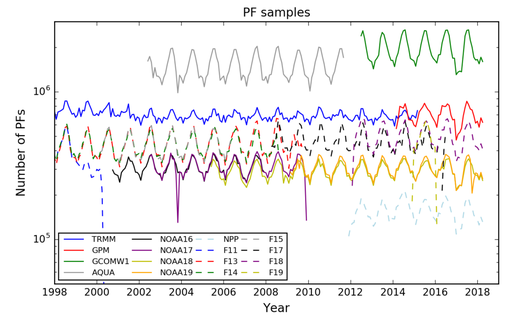






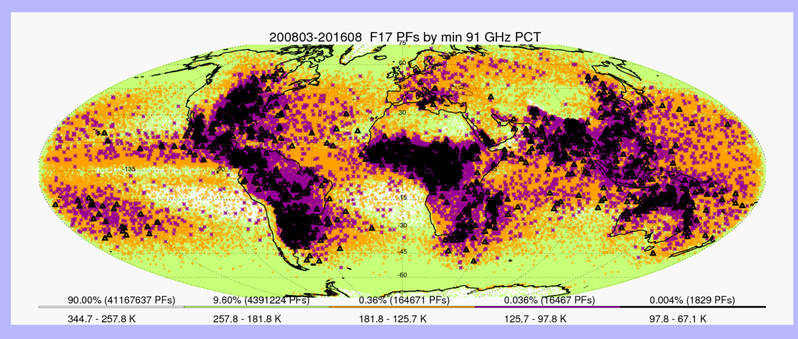
The intense convection is identified by categorization of all precipitation features by their rarity of maximum echo top heights or minimum brightness temperatures. The distribution of coldest 165H and 165V brightness temperature, and 183 ± 3 and 183 ± 7 GHz are quite similar, therefore only one of them is shown here.

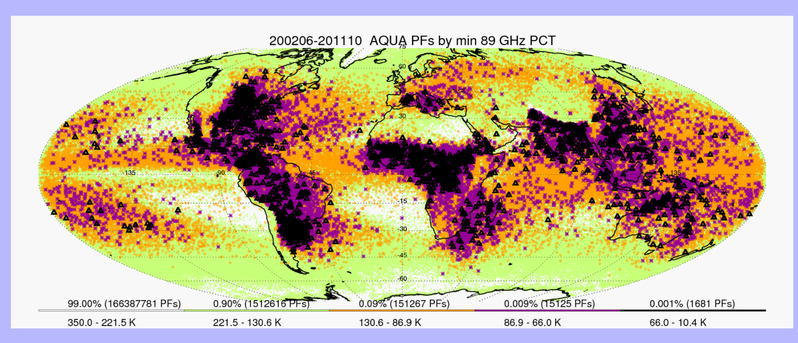
Intense convection from constellation satellites



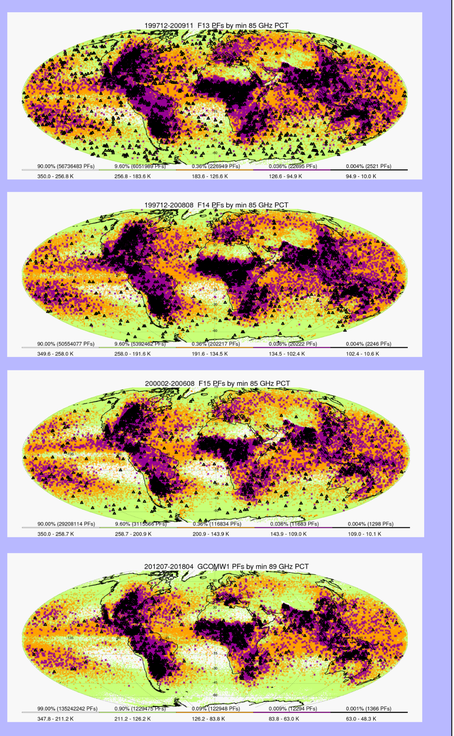
Precipitation features are defined by grouping contiguous surface precipitation area using GPROF retrievals. Calibrated 1C brightness temperature products are used to derived the minimum 85 and 37 GHz PCTs

Satellite	Sensor	Swath (km)	85-91 GHz Resolution (km)	Periods	PFs (#)
TRMM	TMI	760	11x16 km (85.5 GHz)	1997.12-2015.04	144598515
GPM	GMI	850	5x7 km (85.5 GHz)	2014.03-2018.04	34862569
GCOMW1	AMSR2	1450	3 x5 km (89.0 GHz)	2012.07-2018.04	136816700
AQUA	AMSR-E	1450	4.4 x7.2 km (89.0 GHz)	2002.06-2011.10	167953988
F11	SSM/I	1400	11x16 km (85.5 GHz)	1997.12-2000.05	10434745
F13				1997.12-2009.11	62847019
F14				1997.12-2008.08	56171458
F15				2000.02-2006.08	32338395
F16	SSMIS	1700	13.1 x14.4 km (91 GHz)	2013.12-2017.09	4737995
F17				2008.03-2016.08	45595617
F18				2012.02-2018.04	37325610
F19				2014.12-2016.02	6818591
NPP	ATMS	2200	32 km (89.5 GHz QV)	2011.12-2018.04	11985623
NOAA16	AMSU-B	2250	16 km (89 GHz V)	2000.10-2007.12	26894725
NOAA17				2002.06-2009.12	28119225
METOPA	MHS	2180	16 km (89 GHz V)	2006.12-2018.04	39213270
METOPB				2013.04-2018.04	17610239
NOAA18				2005.05-2018.04	45401589
NOAA19				2009.02-2018.04	3542952

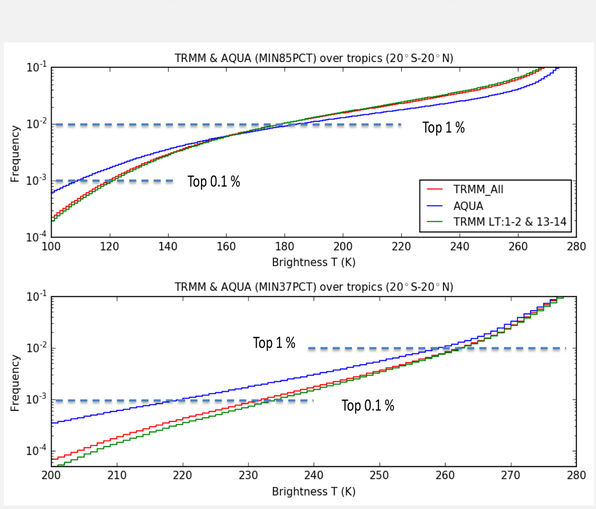


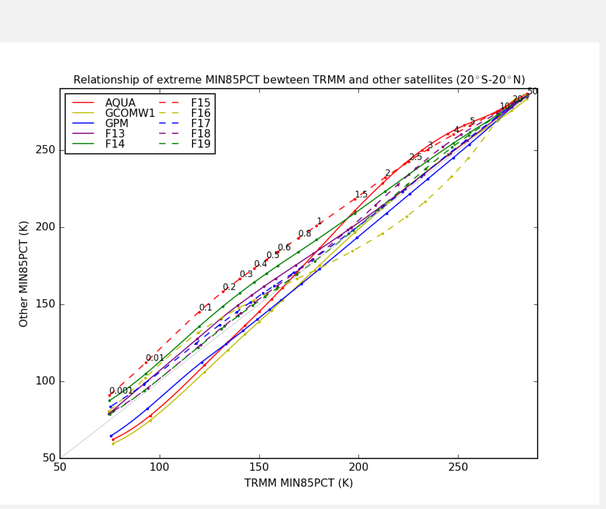


Though radiometers onboard different constellation satellites have different frequencies, resolution, and sensitivity. Based on the rarity of the coldest brightness temperatures, they all indicate similar geographical distribution of intense convection with strong ice scattering signals.



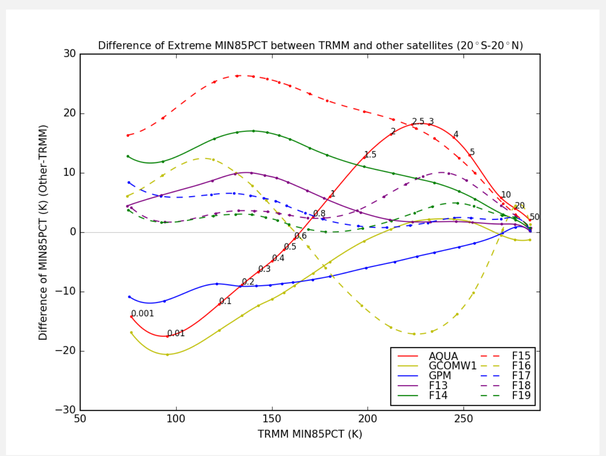
Inter-comparing coldest brightness temperatures from different satellites

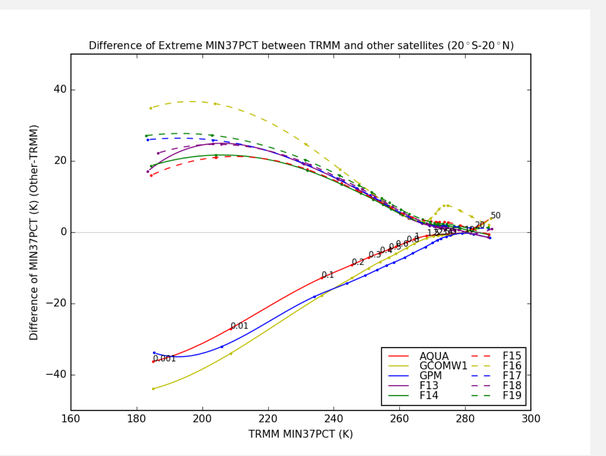




Due to different resolutions, PFs from AMSR-E and TMI have different cumulative distributions as function of minimum 85/89 and 37 GHz PCTs. Part of difference may also come from the diurnal variation of intense convection and sun-synchronous orbit of AQUA. If we assume the rarity of the intense convection being similarly observed by different satellites, there is possibility that we may inter-compare the minimum brightness temperatures.

After resampling the TRMM at different constellation overpass times, the corresponding minimum 85 GHz PCTs of PFs from constellations are derived with TRMM at the same rarities. For radiometers with resolution higher than TMI (AMSR-E, AMSR2), the PFs of same rarity have colder minimum 89 GHz PCTs than that of TMI. The radiometers of lower resolutions have relatively higher minimum TBs due to the beam filling.





Based on the rarity of the PFs categorized by minimum brightness temperatures around 89 and 37 GHz, and the common sampling periods from constellation satellites and TRMM, it is possible to build look up tables to inter-compare the convective intensity of PFs from different constellation satellites. This could be the first step towards understanding the long term variability of intense convection at regional and global scales using passive microwave observations. Also note that the rarity can also be based on the occurrence of intense convection per sample area as well. There are also concerns on sounders with non-uniform pixel sizes. Nevertheless, 20 year PFs from constellation satellites provide a great opportunity to understand the long term variability of intense convection and precipitation systems.

Summary:

- New precipitation feature databases are created with 20 year GPROF and 1C brightness temperature products and available to public at: http://atmos.tamucc.edu/trmm/data/
- Though passive microwave radiometers onboard constellation satellites have various sensitivity, resolution, and local overpass times, it is still possible to inter-compare their observations in the intense convection based on the rarity of these events.
- 20-year precipitation features from passive microwave observations provide a great opportunity to understand the variability of intense convection regionally and globally, and how intense convection change under recent climate variations.

Acknowledgements:

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